



Militarily Critical Technologies List (MCTL) “Space Optics”

Review and Update

June 15, 2009

What is the MCTL

The MCTL is a compendium of existing goods and technologies that DOD assesses would permit significant advances in the development, production and use of military capabilities of potential adversaries. It includes goods and technologies that enable the development, production, and employment of weapons of mass destruction.

Overview of basis for the MCTL

- Required by Export Administration Act
- Serves as a technical reference for the development and implementation of DoD technology security policies on international transfers of defense related goods, services, and technologies as administered by the Director, Defense Technology Security Administration (DTSA).
- Updated by Institute for Defense Analyses under contract to OSD.
- Status of current ITAR legislation - Passed Full House on June 10th - No affect on current trade with China - Moves space technology from State Dept to Commerce Dept
- Commerce Dept Control List - data from MCTP
- Congress has not passed a State Dept Authorization bill since 2002

Why should the MCTL be important to you?

- Updates may minimize the impact on specific industrial exports by clearly identifying MCT parameter levels.
- It provides a basis for international controls for truly militarily critical techs.
- It optimizes the release of dual-use technologies and technology items that are not considered militarily critical.

OSD Objectives of MCTL Update

- Identify current Militarily Critical Technologies.
- Update the MCTL at least every two years.
- Remove, modify and/or add militarily critical technologies and parameter levels as required.
- Establish updated Militarily Critical Technology parameters & parameter levels.
- Identify Worldwide Capabilities.

Current Status of Space Optics Tech.

- There are three Technologies currently listed in Section 19-4 of the MCTL Space Systems Technology List.
- Last complete update was in 2007
- Recent improvements in many optics technologies and changes in military applications of space platforms requires a serious technical review & update.

Updates for the Space Optics Tech.

- IDA is scheduled to submit the updated Section 19 of the MCTL to OSD by 30 June for DOD coordination.
- The Technology Working Group for Space Optics needs all inputs by COB June 17th, 2009 to meet this.

What can you do to help?

- Please review Section 19-4 of the MCTL at www.dtic.mil/mctl
- Provide inputs and recommended additions, deletions, or changes to the Space Optics technologies to:

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Identifying Militarily Critical Space Optics Technologies

- Space technologies are defined as technologies “unique to the space environment” or “designed specifically for space applications”.
- Militarily critical optics technologies identified for terrestrial and air applications (should be identified) and will be included in the general optics Section 11 of the MCTL.
- Technologists familiar with space optics and military requirements are asked to provide new technologies & propose changes for consideration during this review & update.

Defining Militarily Critical Parameters

- Militarily Critical Technology Parameters are defined as the level of capability which may provide significantly military capability to an adversary.
- MCTL parameters (and parameter levels) ensure critical U.S. military technological advantages are preserved, and transfers which could prove detrimental to U.S. security interests are controlled and limited.
- Updates ensure relevance and currency of the MCTL to enable DoD Components to utilize the MCTL in making technology transfer decisions and recommendations for international control of critical technologies.

Current Space Optics Technology Areas

- DEPLOYABLE MONOLITHIC AND SEGMENTED OPTICS.
- DEFORMABLE MIRRORS/ADAPTIVE OPTICS AND SUPPORT MECHANISMS.
- MICRO-OPTO-ELECTRO-MECHANICAL SYSTEMS (MOEMS).

DEPLOYABLE MONOLITHIC AND SEGMENTED OPTICS

- Lightweight, high stiffness precision monolithic structures with:
 - a. an areal density of $< 15 \text{ kg/m}^2$; and
 - b. a fundamental frequency $> 1.5 \text{ kHz}$.
- Optical “Composite” Components having:
 - a. a coefficient of linear thermal expansion $< 5 \times 10^{-6}$ in any coordinate axis;
 - b. an areal density of $< 20 \text{ kg/m}^2$; and
 - c. a fundamental frequency $> 1.5 \text{ kHz}$.
- Segment mirrors or mirror assemblies designed to be assembled in space with:
 - a. optical segments (for segmented mirrors) $> 0.5 \text{ m}$; or
 - b. full aperture optics $> 3 \text{ m}$.
- Technology for measuring Zero-g figure and tolerances in 1-g conditions (terrestrial setting) for lightweight space optics structures $< 30 \text{ kg/m}^2$.

DEPLOYABLE MONOLITHIC AND SEGMENTED OPTICS

(Cont.)

- Rapid optical fabrication technology for large ($> 10 \text{ m}^2$) monolithic or segmented primary mirrors.
- Hinges, latches and related mechanisms capable of providing control to $< 10 \text{ nm}$ mirror surface figure stability.
- Optical structure isolation systems with:
 - a. damping coefficients of $> 30 \text{ dB}$; and
 - b. for frequencies between 1 Hz and 105 Hz .
- Vibration-isolation and damping systems for flexible structures to achieve $< 30 \text{ nm}$ mirror position stability.
- Visible and infrared wavelength high reflectance, low stress, durable, optical coatings which can survive the space environment of atomic oxygen for > 5 years.
- Optical component coating protection technology for atomic oxygen.
- All space-based high energy laser (HEL) optics.

DEFORMABLE MIRRORS/ADAPTIVE OPTICS AND SUPPORT MECHANISMS

The militarily critical parameters listed below are optical components for space applications. Some components dynamically or statically move the surface of an optic. They include components specially designed for space applications, which can correct laser beam wavefronts, such as non-linear optical components or liquid crystal modulators (in conjunction with advanced optics or as stand alone components) as follows:

1. **Actuators:**
 - a. Working at a frequency > 200 Hz but ≤ 300 Hz;
 - b. with a positioning and repositioning accuracy < 30 nm;
 - c. precision < 20 nm; and
 - d. a full stroke > 3 μm .
2. **Actuators:**
 - a. At a frequency > 300 Hz;
 - b. with a positioning and repositioning accuracy < 30 nm;
 - c. precision of < 50 nm; and
 - d. a full stroke > 3 μm .
3. **Actuators:**
 - a. With large stroke range > 5 mm; and
 - b. high resolution positioning accuracy (< 30 nm).

DEFORMABLE MIRRORS/ADAPTIVE OPTICS AND SUPPORT MECHANISMS (Cont.)

4. **Deformable optical mirror surfaces.**
 - a. With < 30 nm deviation from prescribed figure in dynamic or static configurations; and
 - b. optical diameter or major axis of > 25 mm.
5. **High-precision mechanisms for optical system deployment in space with positioning of:**
 - a. $< 1 \times 10^{-5}$ meter accuracy; and
 - b. < 1 part in 10^6 precision.
6. **Advanced control system and actuator designs for optical-precision structural controls with controlled movement of $< 10^{-9}$ meters/meter of separation between optical elements.**
7. **Optical beam steering optical components with:**
 - a. Diameters (or major axis) > 10 cm;
 - b. flatness < 50 nm; and
 - c. a control bandwidth > 200 Hz.
8. **Non-linear optics components, such as liquid crystals and other phase control material components, specially designed for space optics applications and use as follows:**
 - a. Nonlinear phased arrays with > 250 μ sec switching speed;
 - b. wide-angle beam steering $> \pm 45^\circ$ field of regard; and
 - c. high-speed liquid crystals $> 10^4$ Hz.

MICRO-OPTO-ELECTRO-MECHANICAL SYSTEMS (MOEMS)

- MOEMS with a frequency > 500 Hz.
- MOEMS with all of the following:
 1. ≥ 100 actuator mirrors;
 2. $\geq \pm 1$ -micrometer displacement throw; and
 3. $> 95\%$ areal density (fill factor).

Conclusions

- **Your** inputs are needed to improve the MCTL by identifying current MCTs, respective parameters, and critical parameter levels.
- Participation in these MCTL updates is a key forum for industry and academia to impact technology control processes.
- Any and all suggestions are welcome.
- Not all suggestions will be incorporated, but **all** will be considered and seriously reviewed!
- Please provide suggestions to r.v.wick@juno.com by COB 6/17/09.